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Modeling capital structure decisions in a transition market: empirical analysis of firms in Egypt

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Abstract It has been realized that none of the three basic theories of capital structure presents a complete answer to the actual determinants of corporate financing decisions. This study attempts to model the practice of capital structure decisions according to the basic premises of each theory of capital structure: trade-off theory, pecking-order theory and free cash flow theory. The methodology addresses modeling long-term and short-term debt financing decisions based on ten different statistical criteria using data from Egypt stock market. The empirical evidence indicates that four models of corporate financing are influenced by the trade-off theory relatively. The contributions of this paper are as follows. First, this study offers a more refined and comprehensive methodology for modeling firms' capital structure decisions. Second, the results of this study compare to those of previous studies of other developing countries and thus add an element of external validity.

Keywords Capital structure · Modeling · Subset selection · Egypt

JEL Classification G32

1 Introduction

The literature on the theory and practice of capital structure is extensive. Researchers have attempted to provide answers to such questions as what are the factors that affect firm's

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decision to change its capital structure (e.g., leverage or debt ratio). The research on the determinants of capital structure has provided a wide range of factors that combine the effects of trade-off theory, pecking order theory and free cash flow theory (Chen and Kim 1979; Myers 2001; Sánchez-Vidal and Martin-Ugedo 2005). This research has been oriented to determine the factors that matter (or do not matter) in explaining variations in firms' capital structure (Miller 1988). The empirical research on tests of theories of capital structure follows standard, and mostly conventional, estimation procedures to examine the critical determinants of capital structure according to the premises of a certain theory. These procedures rely on the standard statistical runs that depend on conventional criteria for choosing certain model(s). To that end, this study extends the statistical procedures by employing comprehensive statistical criteria to choose the model that best reflects the practice of debt financing.

In reality, it is hard to assume that corporate financing decisions are made according to the precise assumptions of a certain capital structure theory. Rather, it is more tolerable to assume that corporate financing decisions are affected by many different factors (internal and external) that require further investigation. Myers (2001) states that the three theories of capital structure are 'conditional' in a sense that each works out under its own assumptions and propositions. Therefore, none of the three theories can give a complete picture of the practice of the determinants of corporate financing (capital structure) decisions. That is, in practice, it is expected that when the business conditions change, the financing decisions and strategies may change, moving from one theory to another. For example, in certain times, the tax rate may be high enough to encourage more debt financing to take advantage of tax savings or tax shields (trade-off theory). When some economic factors change and the tax shields are not that encouraging, the firm may seek financing from internal sources (pecking order theory) until the tax conditions favor more borrowing. Moreover, a firm may deliberately consume the free cash flow (when it heavily depends on internal sources of financing to finance investment projects) to prevent the agency problems from arising. In sum, it is easily observable that two or more theories of capital structure may exist and affect corporate financing strategies at the same time. This requires more investigation of the factors or determinants that actually affect corporate financing decisions. This paper examines number of determinants of capital structure that have been considered proxies for each of the three theories of capital structure.

1.1 Why modeling capital structure in transition market?

The search for the most reliable and relevant determinants of capital structure in a transition market is particularly significant for certain reasons. First, compared with developed markets, the stock markets in transitional countries are relatively less efficient which raises the importance of searching for the most reliable factors that determine the practice of capital structure decisions. Second, information asymmetry in transitional markets is relatively higher than that of developed markets. This means that the capital structure decisions may not be foreseen. This requires an examination of the financial factors that help lessen the degree of asymmetry. Third, in a stage of transition, the countries' capital markets are quite influenced by global forces mostly from developed markets. This raises the question of the extent to which the determinants of capital structure that have evolved in developed markets have an influence generally in a

transition market and particularly in Egypt. According to the three reasons mentioned above, the paper tests the hypothesis that:

> Due to transitional markets less efficiency, information asymmetry and global convergence, capital structure decisions in transition markets are relatively influenced by the three theories of capital structure.

The methodology of this paper utilizes a model selection approach to determine the most common factors that are associated with firm's capital structure decision. The basic objective of the paper is to choose a group of factors (or determinants) that affects firms' debt financing decisions the most. This group can be viewed as a model that describes the practice of firm's financing decisions. This process is to do with modeling firms' capital structure decisions. In regression analysis, modeling depends on selecting a group (or subset) of factors according to number of statistical criteria. That is, in regression analysis, the subset selection of predictors that should be used is an important problem when building a regression model. In general, the reasons for subset selection include (1) identifying important and negligible predictors; (2) modeling the relationship between the dependent variable and the predictors as simply as possible; (3) minimizing cost of prediction. Several subset selection criteria have been proposed in the statistics literature. These criteria select the subset that minimizes a quantity usually expressed as the logarithm maximum likelihood residual sum of squares plus a penalty function which depends on the subset size. Different penalty functions result in different criteria. The most popular criteria are Akaike's Information Criterion AIC (Akaike 1973), Bayes Information Criterion BIC (Schwarz 1978) and C_p (Mallows 1973). For a good survey see Hocking (1976), Draper and Smith (1981) and Miller (1990) among others. In this study we employ ten subsets selection criteria (which are discussed in Sect. 5) to identify the most common determinants that are highly associated with firm's capital structure decisions.

The contribution of this paper can be outlined in two elements: (a) it is the first attempt to employ subset selection criteria for capital structure modeling in a transition market, (b) In this study, the authors employ ten subsets selection criteria, while recently, using data from a developed market, Frank and Goyal (2004) present a study of choosing the most reliable determinants of capital structure. They used only one criterion, which is the Bayesian Information Criterion (BIC), for the purpose of subset selection. It is worth to note that the ten criteria we employ in the present study offer a relatively high refined modeling process. It is worth to note that the authors focus in the literature review on the determinants of capital structure in developed markets mostly the U.S. This has significant implications to transition markets. That is, since in general the financial institutions and infrastructure in transition markets vary from those of the developed markets, it offers an opportunity for the financial managers in transition markets, particularly Egypt, to learn lesson from developed markets regarding the determinants of capital structure that are to be considered 'relevant' to transitional market settings.

The rest of the paper is organized as follows. Section 2 reviews the relevant literature on the determinants of capital structure. Section 3 describes the research variables and the proxies. Section 4 describes the data used and the methodology employed for the modeling purpose. Section 5 discusses the ten subsets selection criteria used for the modeling process. Section 6 shows the results. Section 7 discusses the results. Section 8 concludes.

2 Determinants of capital structure: review of the relevant literature

The relevant literature on the determinants of capital structure provides number of factors that have been examined or even pointed out. It has been realized that the number of factors differs from one study to another. Therefore, this study examines as a comprehensive number of determinants of capital structure as possible. These determinants cover relatively the tradeoff theory, pecking order theory and free cash flow theory. Some determinants could not be included due to the lack of relevant data. Table 1 summarizes the capital structure determinants examined in this study and the ratio(s) or proxy for each determinant.

3 Variables and research proxies

3.1 Dependent variables

The initial two dependent variables examined in this study are firms' changes in long-term debt ratio ($\Delta LTDR$) and changes in short-term debt ratio ($\Delta STDR$). The measurement of the two variables is to address firms' adjustment to a target value. Therefore, the change in long-term debt ratio is denoted to as $Y_{1t} = \Delta LTDR_t = LTDR_t - LTDR_{t-1}$ and the change in short-term debt ratio is denoted to as $Y_{2t} = \Delta STDR_t = STDR_t - STDR_{t-1}$.

Nevertheless, the practice of corporate debt financing might not seem as simple as its classification into long-term and short-term components. Two potential problems may arise. First, a potential substantial problem arises in that the changes in these two variables are not independent. In particular, a given firm might have short-term debt outstanding in year-end t which is due in year $t + 1$. In year $t + 1$, the firm might borrow long-term debt in part to pay-off maturing short-term debt. In this case, the change in short-term debt (a decrease) occurs simply because the short-term debt matures, while the simultaneous change in the long-term debt (i.e., an increase) occurs simply because the proceeds are needed to pay-off the maturing short-term debt. It is worth noting that a great part of the debt financing pattern in Egypt is a good example of the above mentioned scenario. To deal with this possibility, the authors experiment with a third alternative dependent variable which is the change in all debt (denoted to as $Y_{3t} = \Delta \mathrm{DR} = \mathrm{DR}_t - \mathrm{DR}_{t-1}$).

Second, the use of short-term debt may create another potential problem. Myers (1977) and Graham (1996) argue that firms may limit total debt, or use short-term debt, to minimize underinvestment costs. This theory necessitates the examination of the effect of short-term debt independently which is measured by a fourth dependent variable Y_{4t} = the ratio of short-term debt/Total debt.

3.2 Independent variables

The independent variables refer to the factors that affect firm's debt policy. The authors have covered a wide range of factors of capital structure that were examined in the literature empirically. The independent variables are summarized in Table 1. The summary statistics of the independent variables are presented in Table 2.

Table 1 Determinants of capital structure examined in the literature

Factors (determinants of capital structure)	Variables (ratio/proxy)	Theoretical/Empirical underpinnings
Target debt ratio[a]	DE_{t+1}	Debt-equity ratio in a next period (Marsh 1982; Auerbach 1985)
	ΔDR*	An indicator to the relationship between actual and optimal (target) capital structure (Castanias 1983; Shyam-Sunder and Myers 1999; Ozkan 2001)
Average industry leverage	ΔDR_{AVG}	An indicator to the average leverage level of other firms in the same industry (Bowen et al. 1982; Castanias 1983)
Structure of tangible assets	$FATA_t$ (ratio of fixed assets/total assets)	An indicator to the structure of tangible assets (Martin and Scott 1974; Jensen and Meckling 1976; Schmidt 1976; Myers 1977; Ferri and Jones 1979; Grossman and Hart 1982; Myers and Majluf 1984; Stulz and Johnson 1985; Harris and Raviv 1991; Rajan and Zingales 1995; Ghosh et al. 2000)
Relative tax effects	ΔNDTAX [The ratio of depreciation to total assets $(DEP/A)_t$]	A proxy for non-debt tax shields (DeAngelo and Masulis 1980; Bradley et al. 1984; Ross 1985; Kim and Sorensen 1986; Titman and Wessels 1988; Harris and Raviv 1991; Homaifar 1994; Ghosh 2000; Ozkan 2001)
	$ECTR_t$ (The effective corporate tax rate)[b]	A proxy for debt tax shields (Modigliani and Miller 1963; Toy et al. 1974; Scott 1976; DeAngelo and Masulis 1980; Lasfer 1995; Walsh and Ryan 1997)
	Δ(NDT/A)	A direct estimate of non-debt tax shields over total assets (Titman and Wessels 1988)[c]
Growth	$CETA_t$ (capital expenditures over total assets)	Proxies for firm's future growth rate (Myers 1977; Kim and Sorensen 1986; Harris and Raviv 1991; Ghosh et al. 2000)
	GTA_t (growth of total assets = percentage change in total assets)	
	SG_t (sales growth)	
	$ASTURN_t$ (assets turnover)	
Investment growth opportunities	Market-Book Ratio MB_t (dummy variables)	Firm's growth options (Myers 1984; Titman and Wessels 1988; Haris and Raviv 1990; Lasfer 1995; Rajan and Zingales 1995; Ozkan 2001; Hovakimian et al. 2001).
Bankruptcy risk	BR_t [A direct measure of bankruptcy risk (White and Turnbull 1974; Marsh 1982)][d]	Bankruptcy risk as a proxy for the bankruptcy costs (Warner 1977; Myers 1977; Castanias 1983).
	DCR_t(Debt Coverage Ratio)	A proxy for firm's failure (Castanias 1983; Harris and Raviv 1990)

Table 1 continued

Factors (determinants of capital structure)	Variables (ratio/proxy)	Theoretical/Empirical underpinnings
Agency costs	ER_t (Expense Ratio = Operating expenses scaled by annual sales)[e]	A measure of how effectively the firm's management controls operating costs, including excessive prerequisite consumption, and other direct agency costs (Jensen 1986; Stulz 1990; Ang et al. 2000)
	AUR_t (Assets Utilization Ratio = Annual sales/Total assets)	A measure of how effectively the firm's management deploys its assets (Grossman and Hart 1982; Daigle and Maloney 1994; Ang et al. 2000).
Uniqueness	SES_t [Selling Expenses over Sales (Titman and Wessels 1988)]	The relationship between specialized products and capital structure (Titman 1984; Titman and Wessels 1988).
Industry classification	IC_t (Dummy variables 11 different types of non-financial industries)	The industry effects on firm's capital structure (Schwarz and Aronson 1967; Gupta 1969; Lev 1969; Scott 1972; Scott and Martin, 1975; Schwarz and Martin 1975; Schmidt 1976; Ferri and Jones 1979; Titman and Wessels 1988; Graham and Harvey 2001).
Size	$LnAssets_t$, the natural logarithm of total assets (Dummy variable)	The effects of firm's size on the composition of capital structure (Gupta 1969; Toy et al. 1974; Schmidt 1976; Ferri and Jones 1979; Kim and Sorensen 1986; Titman and Wessels 1988; Chung 1993; Homaifar et al. 1994; Rajan and Zingales 1995; Ozkan 2001; Ghosh et al. 2000).
	$LnSales_t$, the natural logarithm of net sales (Dummy variable)	
Profitability	ΔEBITDA (Earnings Before Interest, Taxes, and Depreciation over Total Assets)	Firm's profitability ratios, which indicate the relationship between firm's profitability and leverage (Toy et al. 1974; Martin and Scott 1974; Schmidt 1976; Carleton and Silberman 1977; Marsh 1982; Long and Maltiz 1985; Titman and Wessels 1988; Harris and Raviv 1991; Whited 1992; Rajan and Zingales 1995; Ghosh 2000; Ozkan 2001).
	ΔOIS (Operating Income over Sales)	
	ΔOIA (Operating Income over Total Assets)	
	ΔPM (Profit Margin)	
	ΔROI (Return on Investment)	
Financial flexibility	REA_{t+1} [The expected effect of 'Retained Earnings Ratio' as a proxy for the retention rate.]	The relationship between retention ratio and target debt-equity ratio, which has its own ground in the 'pecking order theory.' (Marsh 1982; Pinegar and Wilbricht 1989; Opler 1999, Graham 2000).
	ΔREA (A measure of the cumulative effect retained earnings, thus the extent of firm's financial flexibility).	
Liquidity position	ΔQR (Quick Ratio)	The relationship between assets' liquidity and the use of debt (Ozkan 2001).
	ΔWCR (Working Capital Ratio)	
	ΔCashR (Cash Ratio)	
	ΔCR (Current Ratio)	

Table 1 continued

Factors (determinants of capital structure)	Variables (ratio/proxy)	Theoretical/Empirical underpinnings
Interest rate	IR_t (Interest Rate on bank loans)	The relationship between market interest rate and issuing debt (Bosworth 1971; White 1974; Solnik and Grall 1975; Taggart 1977)
Timing effect	ΔPE (Price/Earnings Ratio)	The relationship between stock prices and issuing equity (Bodenhammer 1968; Baxter and Cragg 1970; Bosworth 1971; Taggart 1977; Lucas and McDonald 1990; Hovakimian et al. 2001).
Transaction costs	DPR_t (Dividend Payout Ratio)	The effects of transaction costs of issuing or retiring debt on the choice of capital structure (Martin and Scott 1974; Marsh 1982; Fisher et al. 1989; Gilson 1997)
Free cash flow	FCT_t	Jensen (1986)

[a] There are alternative approaches to calculate the target ratios such as (1) the average over certain number of years; (2) by fitting an autoregressive function; (3) by taking the maximum debt ratio in the past (Marsh 1982). However, the three approaches result in one estimate for the target ratio which gives the impression that firms look at only one certain estimate (ratio) and plan their capital structure accordingly. The method used in this paper is based on the assumption that the firm changes its target ratio generically, then the ratio a firm could achieve is considered as if it was the target ratio. This point of view takes into account the generic aspects of planning for capital structure changes. According to the literature, floatation costs, firm's size, asset structure and the market conditions change over time which necessitate planning for capital structure generically, and the target ratios are changed accordingly. However, we experimented with the three methods plus our suggested one which utilizes the two ratios (DE_{t+1} and ΔDR*). The results showed slightly significant increase in the R^2 for our suggested measures

[b] $\text{ECTR}_t = \frac{\text{Estimated taxable profits} \times \text{Corporate tax rate}}{\text{Pre-tax profits}}$

[c] $NDT = OI - i - (T/CTR)$, where OI = operating income; i = interest payments; T = income tax payments; CTR = corporate tax rate

[d] $\text{Bankruptcy risk} = \frac{\text{Fixed charges} - \text{Earnings before income and tax}}{\sigma \text{ of earnings}}$

[e] The expenses ratio is not assumed to measure all agency costs as discussed in the literature. Nevertheless, and according to the availability of data, this ratio can be considered a first-order estimate and easy-to-measure indicator of the presence of agency costs at the firm level

Table 2 Summary statistics of variables used for modeling the capital structure decision

Variables	Ratio/Proxy	Mean	SD	Min	Median	Max
Long-term debt ratio	$\Delta LTDR_t$	−0.01	0.154	−2	0	1.358
Short-term debt ratio	$\Delta STDR_t$	−0.02	0.427	−5.54	−0.1	3.165
Target debt ratio	DE_{t+1}	−0.01	0.38	−6.13	0.001	4.5
Average industry leverage	ΔADR_{AVG}	−0.01	0.14	−0.54	−0.01	0.48
Structure of tangible assets	$FATA_t$	0.24	0.3	0.002	0.18	5.33
Relative tax effects	$\Delta NDTAX_t$	−0.02	0.23	−4.3	0	0.24
Growth	GTA_t	0.22	1.13	−0.9	0.05	15.05
Investment growth opportunities (MB ratio)	High MB	0.05	0.22	0	0	1
	Average MB	0.29	0.45	0	0	1
	Low MB	0.65	0.47	0	1	1
Bankruptcy risk	DCR_t	76.9	11.4	−8.8	3.01	25.3
Agency costs	ER_t	0.15	0.17	−0.01	0.11	1.8
Industry classification (IC)[a]	IC1	0.03	0.17	0	0	1
	IC2	0.01	0.10	0	0	1
	IC3	0.09	0.29	0	0	1
	IC4	0.08	0.28	0	0	1
	IC5	0.06	0.24	0	0	1
	IC6	0.06	0.24	0	0	1
	IC7	0.07	0.26	0	0	1
	IC8	0.13	0.33	0	0	1
	IC9	0.22	0.41	0	0	1
	IC10	0.07	0.26	0	0	1
	IC11	0.10	0.31	0	0	1
Size ($Ln\text{Assets}_t$)	Large size	0.3	0.46	0	0	1
	Medium size	0.35	0.48	0	0	1
	Small size	0.34	0.47	0	0	1
Profitability	$\Delta EBITDA_t$	−0.03	0.8	−12.2	−0.01	12.3
Financial flexibility	REA_{t+1}	0.21	0.24	0	0.16	4.1
Liquidity position	$\Delta CashR_t$	−0.31	6.2	−13.8	−0.001	1.9
Interest rate	IR_t	0.14	0.01	0.13	0.14	0.16
Timing effect	ΔPE_t	6.86	10.8	−41.5	0.02	20.6
Transaction costs	DPR_t	0.94	11.3	0	0.35	25.1

The two dependent variables are changes in long-term debt ratio ($\Delta LTDR_t$) and changes in the short-term debt ratio ($\Delta STDR_t$). The other variables are the independents. The data covers the years from 1998 to 2004. The sample consists of 99 non-financial firms

[a] ICs are dummies for the industry type. IC1 = Agriculture & Fisheries; IC2 = Gas, Oil & Mining; IC3 = Food & Beverages; IC4 = Mills & Storages; IC5 = Textiles, Garments & Consumers Goods; IC6 = Paper, Packaging & Plastics; IC7 = Chemicals & Fertilizers; IC8 = Pharmaceuticals & Health Care; IC9 = Building Materials, Cement & Contracting; IC10 = Engineering Industries & Electrical Equipments; IC11 = Housing & Real Estate

4 Data and methodology

4.1 Data

The data are obtained from many sources. The data related to firms' income statement and balance sheet are obtained from the firms' annual reports, stock market authorities and Kompass Egypt Financial Year Book (Fiani & Partners). The interest rate data is published by the IMF: International Financial Statistics. The data cover seven years 1998–2004. The total number of firms included in the study is 99 firms. The sample firms were selected according to two criteria. First, the non-financial firms amongst the 100 actively trading firms in Egypt stock market. Second, those non-financial firms amongst the 100 firms with the highest market value.

4.2 Methodology

The methodology in this paper aims at selecting the most important factors that affect firms' long-term debt ratio and short-term debt ratio. The authors employ ten model selection criteria to choose the best subset predictors of the capital structure decisions. Then, the subset which is selected by the maximum number of criteria is chosen to be the identified subset, e.g., the model that shows the group of factors (predictors) that affects the actual financing (capital structure) decision.

5 The statistical modeling approach: the subset selection criteria

Over the last three decades, several subset selection criteria have been proposed and studied in the linear regression models. These criteria have two basic elements. The first element is a function of error variance estimator which measures the goodness of fit. The second is a function of the number of unknown parameters which penalizes overfitting. In general, most selection criteria minimize the quantity:

$$Criteria = n\log(RSS_m) + d_m F \tag{1}$$

where n is the sample size, RSS_m is the minimum least squares' residual sum of squares for the model with m predictors which is equal to

$$RSS_m = \left(y - X_m\hat{\beta}_m\right)^T \left(y - X_m\hat{\beta}_m\right)$$

where $\hat{\beta}$ is the minimum least squares estimates of the model parameters. The constant d_m is the number of parameters m in the model. The constant F represents the penalty imposed to the RSS_m for each additional parameter used in the model. It is worth noting that different penalty constants result in different selection criteria.

5.1 The adjusted coefficient of determination (R_a^2)

The adjusted coefficient of determination R_a^2 is defined as follows:

$$R_a^2 = 1 - \left(\frac{n-1}{n-p}\right)\frac{RSS}{TSS}$$

where p is the number of parameters and TSS is the total sum of squares which is equal to$TSS = \sum (y_t - \bar{y})^2$,$\bar{y}$ is the sample mean. The adjusted coefficient of determination may decrease when adding a variable to the model since the reduction in RSS may be more than offset by the loss of a degree of freedom in the denominator $n - p$. Therefore, the model with the highest R_a^2 is identified as the best model.

5.2 Mallows' criterion (C_p)

Mallows (1973) defines the C_p statistic as:

$$C_p = \frac{RSS_m}{S^2} - (n - 2m)$$

where S^2 is the estimate for the residual variance given by $S^2 = RSS_p/n - p$ and p is the total number of predictors. The C_p criterion identifies the subset of predictors with the smallest C_p value (Mallows 1973; Miller 1990).

5.3 Akaike's information criterion (AIC)

The Akaike's information criterion (AIC) is proposed by Akaike (1973) as a statistic incorporating Kullback-Leibler information with the use of maximum likelihood principles and negative entropy. The AIC is one of the most popular criteria for model selection. It is defined as:

$$AIC = n \log(RSS_m) + 2d_m$$

It is clear that the AIC is a special case of (1) when $F = 2$. The AIC identifies the subset with the smallest AIC value. The AIC tends to overestimate the dimension of the model (Akaike 1973; Miller 1990).

5.4 Bayes information criterion (BIC)

Schwarz (1978) proposed the Bayes information criterion (BIC) as a Bayesian solution to the model selection problem. The BIC was derived as a large sample approximation of Bayes factor using the posterior-probability criterion and evaluating the leading terms of its asymptotic expansion. Schwarz assumed a fixed penalty for guessing the wrong model and considered an infinite sequence of nested models each of which has a non-zero prior probability. The BIC is a special case of (1) when $F = \log(n)$, that is:

$$BIC = n \log(RSS_m) + \log(n) d_m$$

The BIC identifies the subset with the minimum value. When the number of observations is large, BIC penalizes additional parameters much more than AIC, leading to more parsimonious models. In large samples, BIC is equivalent to a Bayesian procedure that selects the model with the highest posterior (Schwarz 1978; Miller 1990).

5.5 Final prediction error (FPE)

Akaike (1969) proposed the FPE to select the best subset by choosing the model that minimizes a form of prediction mean squared error. This criterion is defined as:

$$FPE = \left(1 + \frac{2d_m}{n}\right) S^2$$

where S^2 is the estimate for the residual variance given by $S^2 = RSS_p/n - p$ and p is the total number of predictors. According to Akaike's theory, in a collection of different models, the chosen model is the one with the smallest *FPE*.

5.6 Hannan and Quinn criterion (HQ)

Following a similar approach to Akaike (1969, 1973), Hannan and Quinn (1979) suggested a penalty term as loglog$n$. Hannan and Quinn's criterion (HQ) is defined as:

$$HQ = n \log(RSS_m) + \log \log n d_m$$

HQ criterion is consistent, in a sense that it ensures that the actual model will be selected with probability unity as the sample size increases. HQ is a special case of (1) when F = loglog$n$.

5.7 Smith and Spiegelhalter criterion (SSC)

Smith and Spiegelhalter (1980) employed Bayesian approach for model selection. They showed an approximate correspondence between Bayes factors and criterion (1) when $F = 1.5$. The SSC is defined as:

$$SSC = n \log(RSS_m) + 1.5 d_m$$

5.8 Shibata criterion (SC)

Shibata (1980) investigated the asymptotic efficiency of AIC and showed that, when the true model has infinite dimension, AIC is efficient as the sample size approaches infinity. Shibata's criterion (SC) is defined as:

$$SC = n \log(RSS_m) + n \log(n + 2d_m)$$

It is worth noting that *SC* is a special case of (1) when $F = n(\log(n + 2d_m)/d)$. The SC identifies the subset with the smallest *SC* value (Shibata 1980; Miller 1990).

5.9 Risk inflation criterion (RIC)

George and Foster (1994) proposed the Risk Inflation Criterion (RIC) which minimizes

$$RIC = n \log(RSS_m) + 2p \log(d_m)$$

The *RIC* asymptotically minimizes the maximum predictive risk inflation when the predictors are orthogonal. In addition, the *RIC* is conservative since it is related to the expected size of the largest t-statistic when all predictors are orthogonal and their coefficients are zeros (George and Foster 1994; Foster and George 2000; Miller 1990).

5.10 Bias-variance criterion (BIVAR)

Young (1982) suggested the Bias-Variance *BIVAR* Criterion as a weighted mean of Mallows' criteria C_p and the number of parameters d_m. The *BIVAR* is defined as:

$$BIVAR = wC_p + (1 - w)d_m$$

where w is a constant weight. In this study we set $w = 0.5$.

6 Results

It is worth noting that the ten criteria are monotone functions of the residual sum of squares *RSS* for subsets with the same number of predictors. That is, the best subset is the one that minimizes *RSS* for each size r, where $r = 1,2,\ldots,P - 1$. Nevertheless, the direct search for the subsets with minimum *RSS* by visiting all possible subsets is impractical since the number of candidate subsets increases exponentially with the number of predictors. In fact, in our case where 28 predictors are considered, the direct search for best subsets takes 22 days!, using a Pentium 4, 2400 MH PC.

Other authors such as Furnival and Wilson (1974) and Hocking (1976) have developed elegant procedures which reduce the amount of computations required for examining a subset and avoid examining all possible subsets. The Minitab package reports the subsets with the maximum R^2 (or equivalently with minimum *RSS*) for each number of predictors. Then, a Matlab macro is written by the authors to compute the other criteria (which are not reported by Minitab) where *RSS* is used as an input in the Matlab macro.

6.1 How does the subset selection work?

This section shows the empirical results of the statistical modeling of the determinants of long-term debt and short-term debt. This section is organized as follows. First, according to the statistical modeling process, it describes how the subset selection is done. The results of the statistical modeling of long-term and short-term debt ratios are presented in Tables 3 and 4. Second, this section shows the results of the potential use of short-term debt to minimize underinvestment costs which are presented in Table 5 and the results of the potential overlap between short-term and long-term debt are presented in (6).

Table 3 shows the subset of predictors that influence the long-term debt financing. In Table 3, each column represents the selected model by one criterion while each row represents the status of the corresponding predictor selected by each criterion. When a predictor is included in the selected model by one criterion, a check mark $\surd$ is put in the intersection cell of the predictor's row and the criterion's column.

In search for the candidate group (subset) of determinants of long-term debt financing, two approaches are developed. The first approach is to search for the criteria that include the same number of variables. Table 3 shows that there are two candidate subsets of determinants of long-term debt financing. Each of the two subsets is selected by three criteria. The first subset is selected by C_p, FPE and BIVAR criteria and it includes the variables DE_{t+1}, $FATA_t$, ΔNDTAX$_t$, GTA_t, MB1 (high growth opportunities), REA_{t+1}, and IR_t. The second subset is selected by AIC, HQ and SSC criteria and it includes the variables DE_{t+1}, ΔADR_{AVG}, $FATA_t$, ΔNDTAX$_t$, GTA_t, MB1, REA_{t+1}, and IR_t. Note that the second subset has one additional determinant which is average industry leverage ΔADR_{AVG}.

Table 3 Best subsets for long-term debt financing

Variables	Model selection criteria										n_i
	R_a^2	CP	AIC	BIC	FPE	HQ	SSC	SC	BIVAR	RIC	
DE_{t+1}	√	√	√		√	√	√	√	√	√	9
ΔADR_{AVG}	√		√			√	√	√		√	6
$FATA_t$	√	√	√	√	√	√	√	√	√	√	10
$\Delta NDTAX_t$	√	√	√		√	√	√	√	√	√	9
GTA_t	√	√	√	√	√	√	√	√	√	√	10
MB1	√	√	√		√	√	√	√	√	√	9
MB2								√		√	2
DCR_t								√		√	2
ER_t								√		√	2
IC1								√		√	2
IC2								√		√	2
IC3								√		√	2
IC4								√		√	2
IC5								√		√	2
IC6								√		√	2
IC7								√		√	2
IC8								√		√	2
IC9								√		√	2
IC10								√		√	2
IC11								√		√	2
Large-size firms								√		√	2
Medium-size firms								√		√	2
$\Delta EBITDA_t$	√							√		√	3
REA_{t+1}	√	√	√		√	√	√	√	√	√	9
$\Delta CashR_t$								√		√	2
IR_t	√	√	√		√	√	√	√	√	√	9
ΔPE_t								√		√	2
DPR_t								√		√	2

The second approach for determining the candidate subset is to select the variables which are selected by the maximum number of criteria. This is the approach preferred and adopted by the authors. This can be done when the number of variables corresponding to the elements in the last column n_i: is greater than or equal a certain number. When we choose the variables which are selected by 9 criteria or more we obtain the same determinants of the first subset and the second subset is obtained when we select the variables chosen by 6 or more criteria. Indeed, for this reason the second approach outperforms the first one, considering that the major objective is to select the group of predictors that conform to the maximum number of criteria. Accordingly, the first chosen subset represents the group of determinants that affect the long-term debt financing decision.

Table 4 Best subsets for short-term debt financing

Variables	Model selection criteria										n_i
	R_a^2	CP	AIC	BIC	FPE	HQ	SSC	SC	BIVAR	RIC	
DE_{t+1}	√	√	√		√	√	√	√	√	√	9
ΔADR_{AVG}								√		√	2
$FATA_t$	√	√	√	√	√	√	√	√	√	√	10
$\Delta NDTAX_t$	√	√	√		√	√	√	√	√	√	9
GTA_t	√	√	√	√	√	√	√	√	√	√	10
MB1	√							√		√	3
MB2								√		√	2
DCR_t								√		√	2
ER_t								√		√	2
IC1								√		√	2
IC2								√		√	2
IC3								√		√	2
IC4								√		√	2
IC5								√		√	2
IC6								√		√	2
IC7	√	√	√		√	√	√	√		√	8
IC8								√		√	2
IC9								√		√	2
IC10								√		√	2
IC11	√					√	√	√		√	5
Large-size firms								√		√	2
Medium-size firms								√		√	2
$\Delta EBITDA_t$	√	√	√		√	√	√	√	√	√	9
REA_{t+1}								√		√	2
$\Delta CashR_t$								√		√	2
IR_t	√	√	√		√	√	√	√		√	8
ΔPE_t								√		√	2
DPR_t								√		√	2

The same procedures and approach are used in the case of short-term debt financing, short-term debt/total debt and changes in total debt ratio. The results are shown in Tables 3–6. Scanning the elements of Table 4 indicates that the identified subset for short-term debt financing is selected by C_p, AIC and FPE criteria and it includes DE_{t+1}, $FATA_t$, $\Delta NDTAX_t$, GTA_t, IC7, $\Delta EBITDA_t$ and IR_t. The same identified subsets of predictors are obtained if we choose the predictors that appear in the selected models of 8 criteria or more. Therefore, this subset is chosen to represent the group of determinants that affect the short-term debt financing decision. Similarly, the same procedures are employed to examine the potential overlaps between long-term and short-term debt financing. The results are shown in Table 5. In addition, the potential problem of using short-term debt to minimize the underinvestment problem is examined and the results are presented in Table 6.

Table 5 Best subsets the ratio of short-term debt/total debt

Variables	Model selection criteria										n_i
	R_a^2	CP	AIC	BIC	FPE	HQ	SSC	SC	BIVAR	RIC	
DE_{t+1}								√		√	2
ΔADR_{AVG}								√		√	2
$FATA_t$	√	√	√	√	√	√	√	√	√	√	10
$\Delta NDTAX_t$								√		√	2
GTA_t								√		√	2
MB1	√	√	√		√	√	√	√	√	√	9
MB2				√				√		√	3
MB3	√	√	√		√	√	√	√	√	√	9
DCR_t	√							√		√	3
ER_t	√	√	√	√	√	√	√	√	√	√	10
IC1	√	√	√			√	√	√		√	7
IC2	√	√	√			√	√	√		√	7
IC3								√		√	2
IC4								√		√	2
IC5	√	√	√		√	√	√	√	√	√	9
IC6								√		√	2
IC7	√							√		√	3
IC8								√		√	2
IC9	√	√	√	√	√	√	√	√	√	√	10
IC10	√	√	√		√	√	√	√	√	√	9
IC11	√	√	√	√	√	√	√	√	√	√	10
Large-size firms	√	√	√	√	√	√	√	√	√	√	10
Medium-size firms								√		√	2
$\Delta EBITDA_t$								√		√	2
REA_{t+1}	√	√	√			√	√	√		√	7
$\Delta CashR_t$	√							√		√	3
IR_t								√		√	2
ΔPE_t								√		√	2
DPR_t	√							√		√	3

7 Discussion

The results reported in Tables 3–6 are summarized in Table 7. The latter shows the most common determinants of long-term debt and short-term debt chosen by the most criteria employed by the modeling process. When one determinant is chosen by many criteria, it means that the determinant is highly associated with the measure of capital structure, thus the determinant is quite relevant to explain debt financing decisions in Egypt.

Table 7 indicates many aspects of the practice of corporate debt financing decisions. First, five out of the seven ratios and/or proxies are considered common determinants of

Table 6 Best subsets for the changes in all debt

Variables	Model selection criteria										n_i
	R_a^2	CP	AIC	BIC	FPE	HQ	SSC	SC	BIVAR	RIC	
DE_{t+1}	√	√	√		√	√	√	√	√	√	9
ΔADR_{AVG}								√		√	2
$FATA_t$	√	√	√	√	√	√	√	√	√	√	10
$\Delta NDTAX_t$	√							√		√	3
GTA_t	√	√	√	√	√	√	√	√	√	√	10
MB1	√	√	√		√	√	√	√	√	√	9
MB2								√		√	2
MB3								√		√	2
DCR_t								√		√	2
ER_t								√		√	2
IC1								√		√	2
IC2								√		√	2
IC3								√		√	2
IC4								√		√	2
IC5								√		√	2
IC6								√		√	2
IC7	√	√	√			√	√	√		√	7
IC8								√		√	2
IC9								√		√	2
IC10								√		√	3
IC11								√		√	3
Large-size firms								√		√	2
Medium-size firms								√		√	2
$\Delta EBITDA_t$	√	√	√		√	√	√	√	√	√	9
REA_{t+1}								√		√	2
$\Delta CashR_t$								√		√	2
IR_t	√							√		√	3
ΔPE_t								√		√	2
DPR_t								√		√	2

both long-term debt and short-term debt. These common determinants are equity/debt ratio, fixed assets/total assets, non-debt tax shields, growth of total assets, and interest rates. The robustness of this result is considered when the same predictors are examined with regard to another alternative dependent variable, which is the change in total debt ratio. The latter shows that three predictors (equity/debt ratio, fixed assets/total assets and growth of total assets) out of the five common predictors are also determinants of the change in total debt ratio. This result indicates a considerable resemblance between long-term and short-term debts when making capital structure decisions. That is, short-term debt is renewable and used on long-term basis as a source of long-term debt financing. This supports the debt financing scenario mentioned earlier in the description of the dependent

Table 7 Determinants of capital structure: what explains debt financing?

Dimension of capital structure	Long-term debt ratio Ratio and/or Proxy (*Agreed upon by at least 9 model-selection criteria*)	Short-term debt ratio Ratio and/or Proxy (*Agreed upon by at least 8 model-selection criteria*)	Short-term debt/total debt Ratio and/or Proxy (*Agreed upon by at least 9 model-selection criteria*)	Changes in total debt ratio Ratio and/or Proxy (*Agreed upon by at least 9 model-selection criteria*)	Common determinants of debt financing (*Agreed upon by 3 or 4 dependents*)
Target debt ratio	Equity-debt ratio	Equity-debt ratio		Equity-debt ratio	√
Assets' tangibility	Fixed assets/total assets	Fixed assets/total assets	Fixed assets/total assets	Fixed assets/total assets	√
Relative tax effect	Non-debt tax shields	Non-debt tax shields			
Firm's growth	Growth of total assets	Growth of total assets		Growth of total assets	√
Timing borrowing decisions	Interest rate	Interest rate			
Investment opportunities	Market-book ratio (high MB ratio is selected by the nine criteria)		Market-book ratio (high MB ratio is selected by the nine criteria) Market-book ratio (low MB ratio is selected by the nine criteria)	Market-book ratio (high MB ratio is selected by the nine criteria)	√
Financial flexibility	Retained earnings/total assets				
Type of industry		Industry classification (Chemicals & Fertilizers Industry is selected by the eight criteria)	Industry classification (Textile & Garments, Building, Cement & Contracting, Engineering & Electrical, Housing & Real Estate Industries are selected by the eight criteria)		
Profitability		Earnings before interest, tax, and depreciation/ total assets		Earnings before interest, tax, and depreciation/ total assets	
Agency costs			Expense ratio		
Size			Large-size firms		

variables and also comparable to the results of Spanish firms reported by Sánchez-Vidal and Martin-Ugendo (2005).

Second, as for the long-term debt financing, the availability of good investment opportunities in the market is one of the causes to change firm's debt financing. In this case, firms use both long-term debt and retained earnings to finance the available investment opportunities. Table 7 also shows an important aspect of the short-term debt financing. That is, the availability of good investment opportunities (being proxied by high MB ratio) supports Myers (1977) and Graham (1996) theory that firms may use short-term debt financing to minimize underinvestment costs. As for the industry type, the results show that short-term debt financing is considerably important to certain industries which are the Chemicals & Fertilizers, textile & garments, building & contracting, engineering and housing & real estate. In general, industry effects have been studied by Schwarz and Aronson (1967), Gupta (1969), Lev (1969), Scott (1972), Schmidt (1976), Scott and Martin (1975) and Ferri and Jones (1979). They all found significant industry effects on debt ratios. Titman (1984) raised the magnitude of this relationship through studying the liquidation decision where the results indicate that firms that make special products will find liquidation costly. Titman and Wessels (1988) report a negative relationship between debt ratios and the dummy variables that control for and refer to the firms that produce specialized products (such as machines and equipments). Contrary to Titman's (1984) prediction, Graham and Harvey (2001) find that high-tech firms, which are assumed to produce specialized products, are less likely than other firms to limit debt for not giving their customers and suppliers an impression that the firm may go out of business. The results also show that firm's profitability is not to be considered an exclusive determinant of short-term debt financing decisions since it is a also a determinant to changes in total debt ratio. This does not render profitability a robust determinant of short-term debt financing.

Third, Table 7 shows important implications regarding the practice of theories of capital structure. As Myers (2001) points out, the practice of corporate financing decisions could be dominated by the combined effects of the three theories. The contribution of the subset selection approach is to examine the dominant determinants (variables) influencing the practice of debt financing decisions. The results show that in both cases of long-term debt financing and short-term debt financing, the trade-off theory dominates relatively. The trade-off theory assumes that the firm will borrow to a level that balances the tax advantages and possible financial distress. Therefore, firm's tax advantage (tax shield) plays the dominant role in this theory.

The results show that, in the case of long-term and short-term debt financing, the effects of 'target debt ratio' (using debt/equity ratio) and 'tax shields' (using non-debt tax shields) reflect the robust effects of the 'trade-off theory.' The literature provides evidence on the trade-off-related determinants of corporate debt financing. Modigliani and Miller (1963) and Scott (1976) show the effects of corporate tax rate on firm's debt policy. DeAngelo and Masulis (1980) argue that there is a positive relationship in which firms subject to lower corporation tax rates will employ less debt in their capital structure. Lasfer (1995) reports the same positive relationship in the long-run, but no significant effect in the short-run. Walsh and Ryan (1997) found that tax considerations are significant in determining debt and equity decisions of the UK firms. In Toy et al.'s (1974) study, they found that executives regarded tax as a very important debt ratio determinant. The other survey conducted by Graham and Harvey (2001) reports that tax advantage is of moderate importance for medium-size firms, and of high importance for large, regulated dividend-paying firms (e.g., firms that have high corporate tax rates and, therefore, large tax incentives to use debt).

Table 7 also shows the role of other determinants of capital structure. The first determinant is the 'assets tangibility' being measured by the proxy ratio of fixed assets to total assets. In this study, this determinant has robust effects on both firms' long-term and short-term debt financing. In this regard, this result is comparable to Tsai's (2005) result that the optimal capital structure tends to involve debt financing for firms with more value in tangible assets. The literature on the theories of capital structure assumes that tangible assets are easy to collateralize and thus they reduce the agency costs of debt (Myers and Majluf 1984; Stulz and Johnson 1985; Harris and Raviv 1991; Rajan and Zingales 1995). The literature provides some different results on the relationship between debt and fixed assets. On one hand, Toy et al. (1974) show that corporate executives considered liquidity of assets a highly determinant of debt ratio. Schmidt (1976) and Ferri and Jones (1979) found a negative correlation between total debt and the proportion of fixed assets. On the other hand, the works of Galai and Masulis (1976), Jensen and Meckling (1976) and Myers (1977) provide evidence on positive relationships between firm's debt ratios and their collateralized assets. The existence of uncollaterable assets leads a firm to change its capital structure favoring equity financing rather than debt financing. Grossman and Hart (1982) argue that higher collateralized debt levels prevent managers from over consuming firm's perquisites. Myers and Majluf (1984) and Myers (1984) indicate that when managers have better information than outside investors, the former find it advantageous to issue secured debt. In this regard, the information managers have about their firms' assets can positively affect assets collaterlability if this information helps creditors exercising an effective monitoring role. Titman and Wessels (1988) find an effect of assets' collateral value on firm's capital structure choice. Martin and Scott (1974) and Ghosh et al. (2000) find the ratio of fixed assets to total assets a positive and significant determinant of firm's capital structure.

The next determinant that affects both long-term and short-term debt financing is firm's growth being proxied in this study by growth of total assets. The agency theory argues on the existence of a negative relationship between firm's expected future growth and long-term debt levels. As the agency theory states, equity-controlled firms have a tendency to invest suboptimally to expropriate wealth from bondholders and the cost associated with this agency relationship is likely to be higher for growing firms. This negative relationship has been reached by Kim and Sorensen (1986), Harris and Raviv (1991) and Ghosh et al. (2000). Nevertheless, Gupta (1969) and Toy et al. (1974) found that total debt ratios were positively related to growth measured by sales growth and asset turnover. Graham and Harvey's survey (2001) shows that many growth firms claim that customers might not purchase their products if they are worried that debt usage might cause the firm to go out of business. This is consistent with Titman's theory (1984) if growth firms produce unique products.

Although, the results in Table 7 show that market interest rate is a common determinant of both long-term and short-term debt financing, the effect of interest rates disappeared with regard to change in total debt ratio. This does not render interest rate a robust determinant of debt financing.

The results show that the long-term debt financing is also affected by the existence of much investment growth opportunities being proxied by the MB ratio. Table 7 shows that the high MB ratio is chosen as a determinant of long-term debt financing. The literature includes number of works that relate changes in firm's capital structure to the available growth options, hence investment opportunities. The latter are affected by the presence of long-term debt, which can cause an agency conflict between bondholders and shareholders (Myers 1977). That is, shareholders may underinvest if they perceive that the income will be used to pay off existing debt holders. This indicates a negative relationship between firm's debt and growth opportunities. Barclay et al. (1995) indicate that the most important

systematic determinant of a company's capital structure and dividend yield would appear to be the extent of its investment opportunities. Myers (1977) and Graham (1996) argue that firms may limit total debt, or use short-term debt to minimize underinvestment costs. This is quite obvious in Table 7 since the high MB ratio is a determinant of changes in total debt ratio as well. This result comes in contrast to the results of other studies that debt usage is inversely related to growth options. Myers (1984), Williamson (1988) and Harris and Raviv (1990) argue on the relationship between growth opportunities, bankruptcy costs and financial leverage. They argue that the expected bankruptcy costs are higher for firms with greater growth opportunities. This leads to the conclusion that larger expected bankruptcy costs would in turn imply lower financial leverage. Titman and Wessels (1988) present additional evidence in which they argue that firms in growing industries incur higher agency costs since they have more flexibility in taking future investments. Lasfer (1995) provides evidence on the inverse relationship that firms with fewer growth opportunities have more debt in their capital structure. Rajan and Zingales (1995) found a negative correlation between market-to-book ratio and leverage driven by firms with high market-to-book ratios rather than by firms with low market-to-book ratios. This indicates that it is unlikely that financial distress (high leverage), which is associated with firms with low market-to-book ratios, is responsible for the negative correlation as suggested by Fama and French (1992). Lucas and McDonald (1990), Loughran and Ritter (1995), Rajan and Zingales (1995) and Hovakimian et al. (2001) present another reason for the market-to-book ratio to be negatively correlated with book leverage that stems from the tendency for firms to issue stocks when their stocks price is high relative to earnings or book value. Ozkan (2001) presented further evidence on the negative and statistically significant relationship between growth opportunities and leverage. According to his explanation, this negative relationship may give support to the prediction that firms, which have a relatively large proportion of intangible assets can not support a high leverage ratio. Nevertheless, Ozkan found a positive and statistically significant relationship between the lagged growth and leverage. He argues that the positive effect may happen because growth has a transitory effect on leverage ratios.

It is quite interesting to note that the results reported in Table 7 show considerable similarities and convergence with Booth et al.'s study (2001) of the determinants of capital structure in other ten developing countries but Egypt was not included in the sample countries. In the case of Egypt, Eldomiaty and Ismail (2004, 2005) and Eldomiaty (2004) have reached similar results about sample of Egyptian firms using the Bayesian methodology which stands on very different assumptions from the assumptions of the subset selection procedure employed in the present study. The converging and matchable results of those studies, therefore, add to the contribution of this paper since the methodology used in this study is quite different from the ones used in the other related studies mentioned earlier. This also shows a significant element of external validity of the results reported in this study as well as the other related studies. In addition, the matching results of this study and other related studies provide another support to what Booth et al. (2001) have concluded that the theory of capital structure is 'portable.' That is, corporate financing decisions in developing markets are influenced relatively by many determinants of capital structure that have evolved in developed markets.

8 Conclusion

The literature on the theories of capital structure has provided wide range of factors that can be used to describe the practice of corporate financing strategies. This paper is the first

attempt to employ the methodology of model selection for determining the relevant determinants of debt financing decisions in transition markets in general and in Egypt in particular. The methodology used in this paper presents evidence that two models of corporate debt financing (long-term and short-term debt financing) show a robust influence of the trade-off theory. The final results can be considered as a first-order analysis to further examine the conditions under which firms' financing decisions and strategies are made and moving from one theory to another. The contribution of the paper is that the reported results converge relatively and considerably to the results of other related studies in developing markets, which is considered an element of external validity. This is true since the methodologies employed in the other related studies differ from the one used in the present study. The results have also empirical considerations since they show the relevant determinants of capital structure to the Egyptian capital market. These determinants are recommended to the practitioners when making debt financing decisions.

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